CAHFSE Annual Report*

July 1, 2004–June 30, 2005

The Collaboration in Animal Health and Food Safety Epidemiology (CAHFSE) is a joint effort among three agencies of the United States Department of Agriculture: the Animal and Plant Health Inspection Service (APHIS), the Agricultural Research Service (ARS), and the Food Safety and Inspection Service (FSIS). The mission of this important surveillance effort is: (1) to enhance overall understanding of bacteria that pose a food-safety risk by monitoring these bacteria on-farm and in-plant over time, and (2) to provide a means to routinely monitor critical diseases in food-animal production. A particular emphasis of CAHFSE is to address issues related to bacteria that are resistant to antimicrobials. Swine is the first commodity studied as part of the CAHFSE program. Owners of swine herds that meet certain criteria (geographic location and production style) are solicited to participate in the program for a 2-year period. Herds are visited quarterly for data and sample collection.

Reporting Units

A total of 48 sites were visited in 5 States during the period from July 1, 2004, through June 30, 2005. Not all sites were sampled for all 4 quarters since the 48 sites were enrolled in the project at various times during the year and because enrolled sites may not have had market hogs eligible for fecal sampling at every quarterly visit. For example, two sites in Iowa were visited all four quarters while in Texas the three sites that were enrolled were visited only for one or two quarters. The market hog inventory presented here is the average market hog inventory from the sites where fecal samples were collected on at least one visit during the year (table 1).

Table 1. Structure of the coverage population

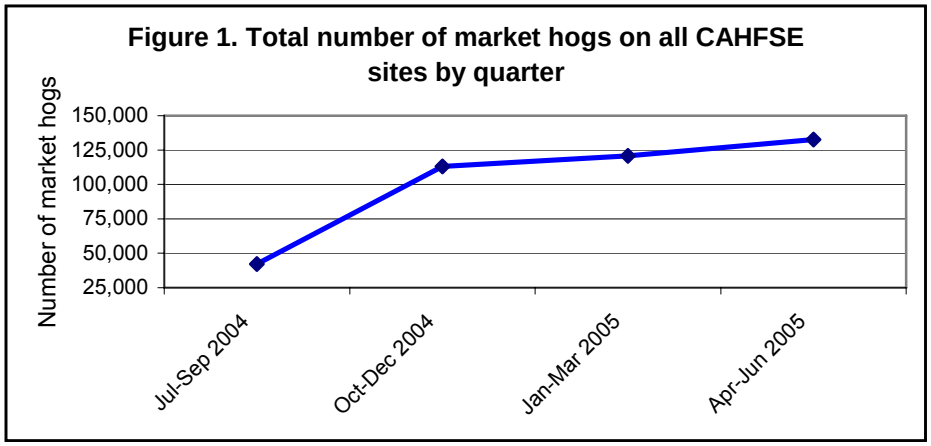
		Number of sites where fecal samples were collected for:				
State	Market hog inventory*	One quarter	Two quarters	Three quarters	Four quarters	One or more quarters
IA	17,162	1	4	3	2	10
MN	25,830	2	3	6	2	13
MO	16,387	0	5	7	0	12
NC	60,616	4	2	4	0	10
TX	815	2	1	0	0	3
Total	120,810	9	15	20	4	48

* Averaged over all quarterly visits

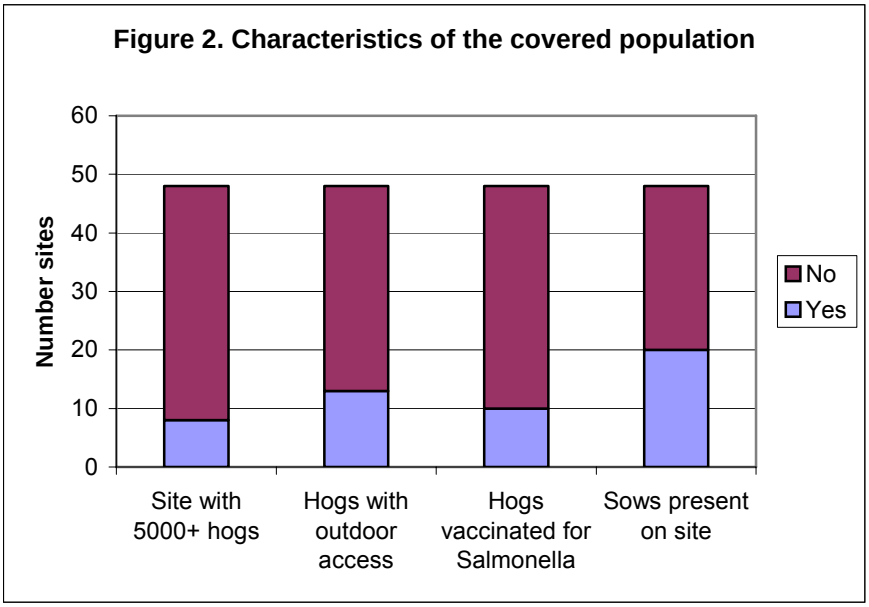
The aggregate number of market hogs on all CAHFSE sites for each quarter is shown in figure 1. These inventory numbers are smaller than those shown in table 1 because the missing visits influence the calculation of the total. The average market hog inventory in table 1 does not account for missing site visits. The rise in this graph reflects the

* This report contains general descriptive results from data and samples collected from July 1, 2004, through June 30, 2005. Estimates of variability are not provided with the data at this time. A more extensive report on the analysis of these data will be provided at a later date and will include estimates of variability to facilitate comparisons among subgroups of the sample population. In the meantime caution is advised in making inference from these results.

resumption of visits for the CAHFSE swine project after temporary difficulties in completing visits during the summer quarter.

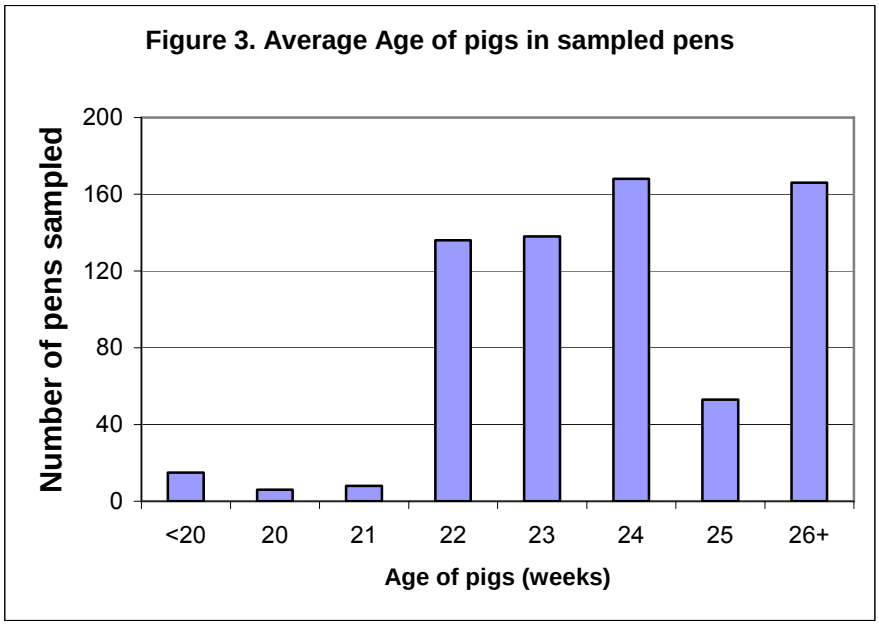


To represent the diversity of swine production facilities, some farrow-to-finish sites were enrolled in CAHFSE as well as sites that had only weaned market hogs. Some indoor-only sites were enrolled as were some sites at which hogs had outdoor access. It was expected that various size sites would be enrolled. Approximately 17 percent of the operations (8 out of 48 sites) had 5,000 or more hogs on site (fig. 2). About 21 percent (10 of the 48 sites) vaccinated hogs for salmonellosis. Thirteen sites allowed hogs access to the outside and 20 sites had sows present on the site.



The majority of hogs in sampled pens were 22 weeks of age or older (fig. 3). This reflects the goal of CAHFSE to collect fecal samples from pens of hogs nearing the end of the finishing phase. Only 4 percent of the pens sampled had pigs that were less than 22 weeks of age.

Figure 3. Average Age of pigs in sampled pens



Recovery of enteric organisms—Salmonella

Overall, 48 sites provided samples from 690 pens to be tested for *Salmonella* and 4,306 samples were tested (table 2). Of the 48 sites that were sampled, 28 (58.3 percent) were positive for *Salmonella* (table 3). A small percentage of pens (20.3 percent) and samples (8.1 percent) were positive.

Table 2. Number of fecal samples collected and tested for *Salmonella*, by *State*

	Sites	Pens	Samples	
State	Number sampled	Number* sampled	Number collected	Number tested
IA	10	123	825	821
MN	13	241	1,360	1,359
MO	12	162	1,240	1,240
NC	10	140	770	729
TX	3	24	160	157
Total	48	690	4,355	4,306

*The number of pens is likely an overestimate because pens identified by numbers were assumed to be different in different quarters, i.e., pen #1 qtr 1 ≠ pen #1 qtr 2.

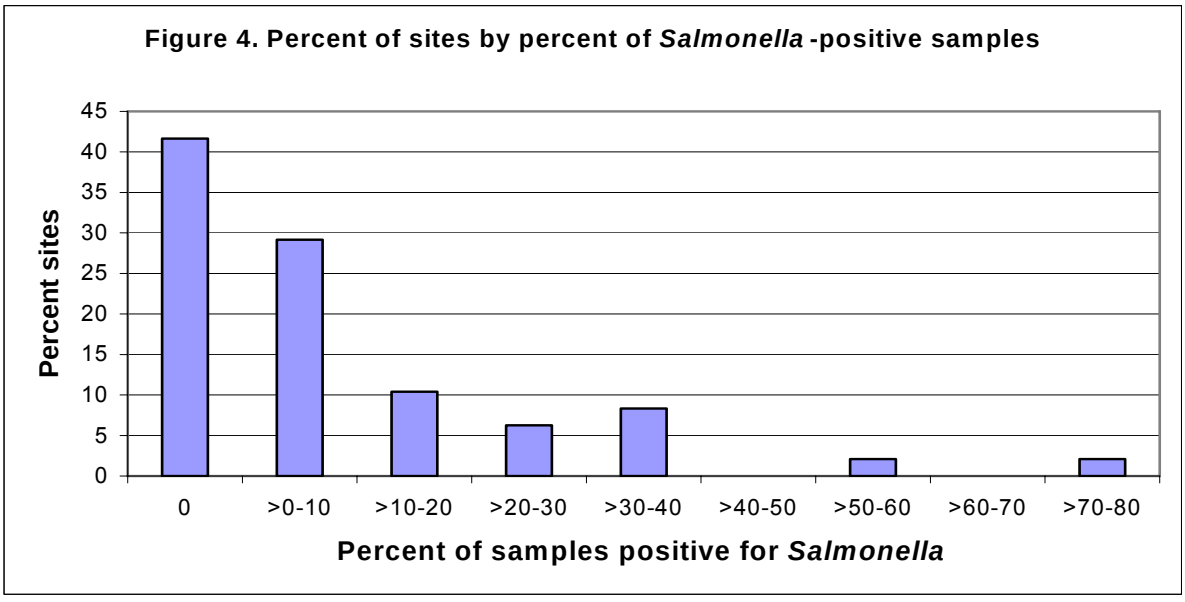
Table 3. Number of fecal samples collected and *Salmonella* prevalence, by *type of site*

	Sites		Pens		Samples		
Sows present on site	Number sampled	Number (%) positive for *Salmonella*	Number sampled	Number (%) positive for *Salmonella*	Number collected	Number tested	Number (%) positive for *Salmonella*
No	28	20 (71.4%)	442	105 (23.8%)	2,460	2,416	249 (10.3%)
Yes	20	8 (40.0%)	248	35 (14.1%)	1,895	1,890	100 (5.3%)
Total	48	28 (58.3%)	690	140 (20.3%)	4,355	4,306	349 (8.1%)

Table 4. Number of fecal samples collected and *Salmonella* prevalence, by *type of facility*

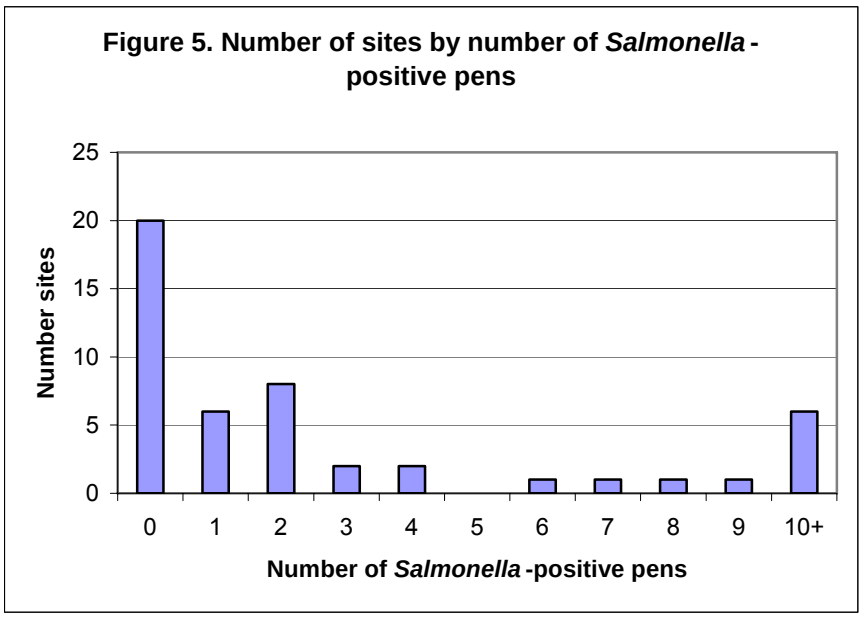
	Sites		Pens		Samples		
Hogs with outdoor access	Number sampled	Number (%) positive for Salmonella	Number sampled	Number (%) positive for Salmonella	Number collected	Number tested	Number (%) positive for Salmonella
No	35	22 (62.9%)	577	126 (21.8%)	3,180	3,132	294 (9.4%)
Yes	13	6 (46.2%)	113	14 (12.4%)	1,175	1,174	55 (4.7%)
Total	48	28 (58.3%)	690	140 (20.3%)	4,355	4,306	349 (8.1%)

The percentage of samples that were positive for *Salmonella* for each site was between 0 and 77.5 percent. On 29.2 percent of the sites, only 1 to 10 percent of samples were positive for *Salmonella* (fig. 4). 4.2 percent of sites had more than 50 percent of samples positive.



Of the 28 *Salmonella*-positive sites, 14 were positive on 2 or more quarterly visits. Of the 48 sites sampled during the year, 38 were sampled for 2 or more quarters.

Most of the positive sites had a small number of positive pens; however, 6 sites had 10 or more positive pens (fig. 5).

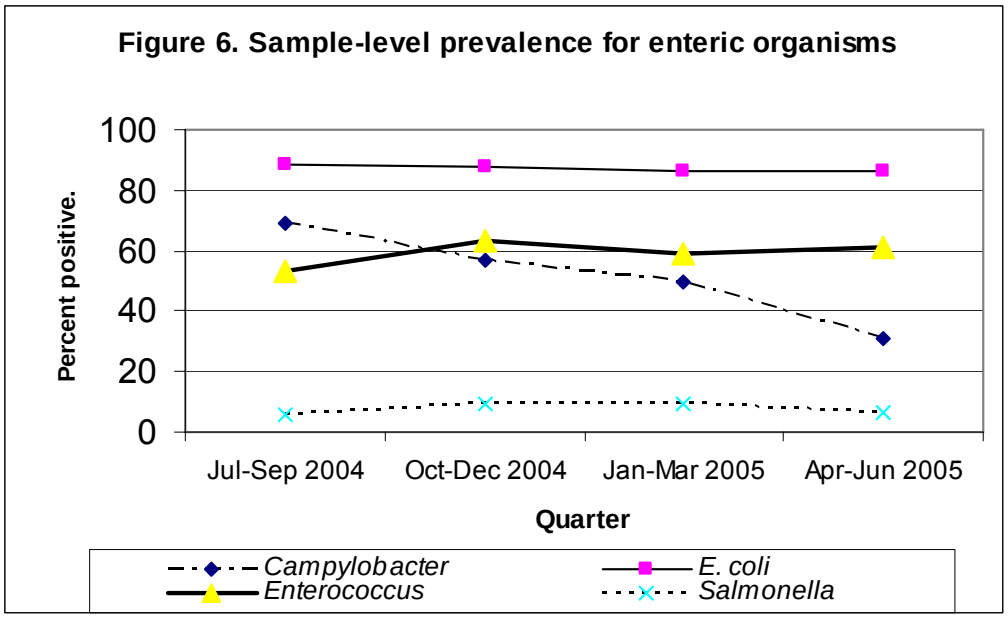


The recovery rate for the other enteric organisms was much higher than for *Salmonella* (table 5). Approximately 40 percent of fecal samples were cultured for enteric organisms other than *Salmonella*. The recovery rate for the four enteric organisms by quarter was fairly stable except for *Campylobacter* where a steady decline was seen (fig. 6).

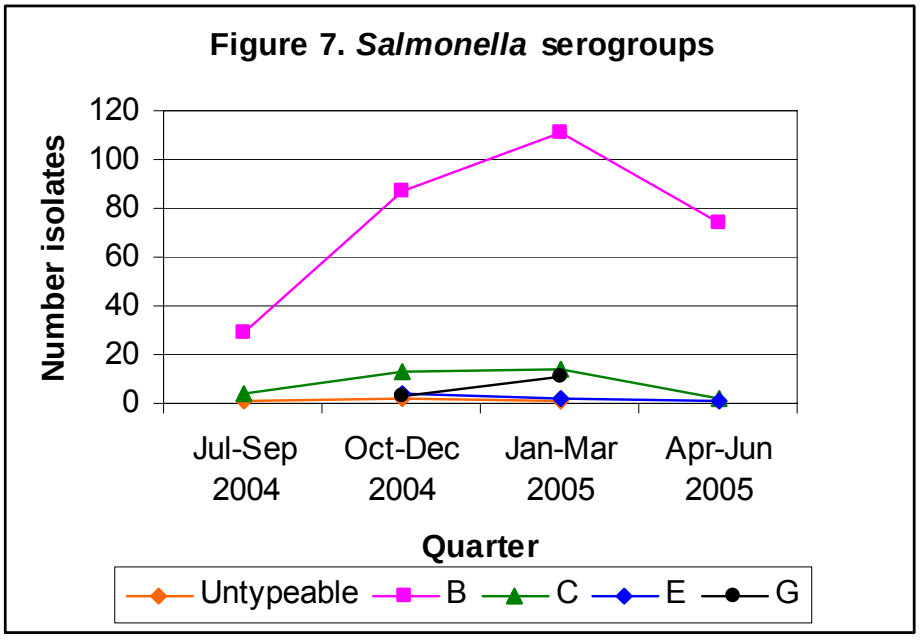
Table 5. Summary of isolation of enteric organisms

Organism	Number tested	Number positive samples	Percent samples positive	Number of samples with multiple isolates	Number isolates
Salmonella	4,306	349	8.1%	9*	359
Campylobacter	1,694	842	49.7%	N/A	842
E. coli	1,726	1,504	87.1%	N/A	1,504
Enterococcus	1,726	1,034	59.9%	0	1,034

*One sample had three isolates.



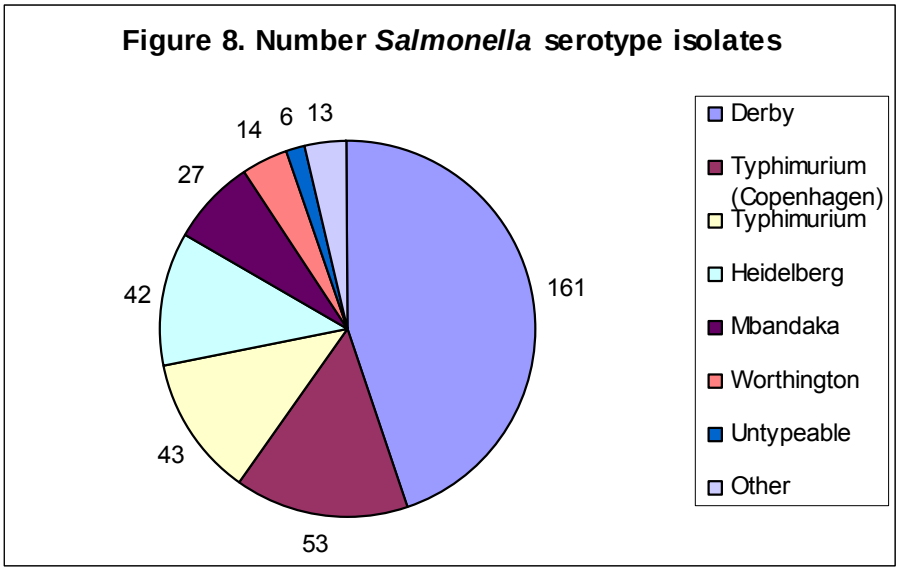
The majority of *Salmonella* isolates are from serogroup B (fig. 7). Isolates from serogroup G were isolated only during two quarters.



Over 59 percent of the *Salmonella* isolates were either serotype Derby or Typhimurium (var. Copenhagen) (table 6, fig. 8). There were 12 different *Salmonella* serotypes isolated (not including untypeable). Multiple isolates were found in some samples which accounts for the 359 isolates from the 349 positive samples.

Table 6. Frequency of *Salmonella* serotypes cultured

Salmonella serotype	Number isolates	Number pens	Number sites
Derby	161	71	18
Typhimurium (Copenhagen)	53	29	11
Typhimurium	43	14	3
Heidelberg	42	18	5
Mbandaka	27	15	5
Worthington	14	9	4
Untypeable	6	5	3
Anatum	4	2	1
Infantis	3	2	1
Meleagridis	2	2	1
Newport	2	2	2
Saintpaul	1	1	1
Senftenberg	1	1	1
Total	359	171	56



Antimicrobial resistance—Salmonella

Table 7 shows the percent of all *Salmonella* isolates that were resistant to each of the antimicrobial drugs on the panel in descending order of resistance. For the purpose of this analysis, isolates that were classified as intermediate were considered susceptible. Almost all isolates (89.7 percent) were resistant to tetracycline. For all other antimicrobials, the majority of isolates were not resistant. None of the isolates was resistant to amikacin, ciprofloxacin, or ceftriaxone.

Table 7. Number and percent of *Salmonella* isolates resistant to each antimicrobial tested

Antimicrobial	Number isolates resistant	Percent isolates resistant
Tetracycline	322	89.7%
Streptomycin	246	68.5%
Sulfamethoxazole	225	62.7%
Ampicillin	166	46.2%
Kanamycin	138	38.4%
Choramphenicol	114	31.8%
Cephalothin	90	25.1%
Trimethoprim/sulfa	85	23.7%
Cefoxitin	77	21.4%
Amoxicillin/clavulanic acid	76	21.2%
Ceftiofur	76	21.2%
Gentamicin	4	1.1%
Nalidixic acid	1	0.3%
Ceftriaxone	0	0.0%
Amikacin	0	0.0%
Ciprofloxacin	0	0.0%

Total number of isolates was 359.

The two most common resistance profiles among the *Salmonella* isolates were tetracycline alone (15.2 percent) or the combination of streptomycin, sulfamethoxazole, and tetracycline (15.2 percent). Tetracycline resistance was a component in each of the 10 most common resistance profiles. The third most common profile was seen in 14.6 percent of isolates, all *S.* Derby (table 8).

Table 8. Top 10 antimicrobial resistance patterns

Antimicrobial resistance pattern	Number of isolates resistant	Percent of resistant isolates (n=336)
Tet	51	15.18%
Strep/Sulfa/Tet	51	15.18%
Amox/Amp/Cefox/Cefti/Ceph/Chlor/Kan/Strep/Sulfa/Tet/Trisul	49	14.58%
Amp/Chlor/Strep/Sulfa/Tet	36	10.71%
Kan/Strep/Tet	19	5.65%
Sulfa/Tet/Trisul	17	5.06%
Amp/Kan/Strep/Tet	17	5.06%
Amp/Kan/Strep/Sulfa/Tet	13	3.87%
Amox/Amp/Cefox/Cefti/Ceph/Chlor/Strep/Sulfa/Tet/Trisul	10	2.98%
Amp/Ceph/Kan/Strep/Sulfa/Tet	10	2.98%

*23 of the 359 isolates were susceptible to all antimicrobials tested.

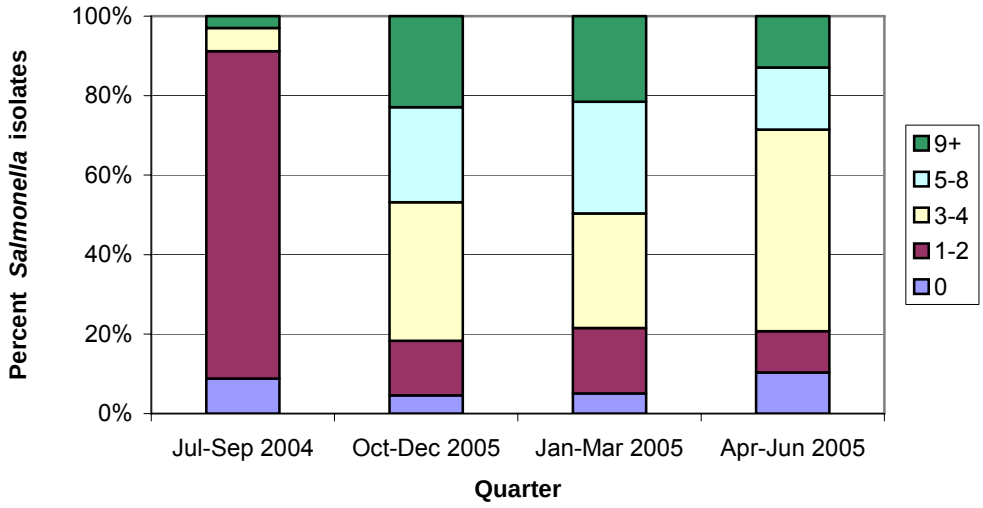
Table 9 shows the top five antimicrobial resistance patterns in descending order by *Salmonella* serotype for Derby, Typhimurium (var. Copenhagen), and Typhimurium. Of Derby isolates, 79.7 percent were multiresistant compared to 92.2 percent of Typhimurium (var. Copenhagen) and 90.3 percent of Typhimurium isolates. Note: table 9 includes only the five most common resistance patterns.

Table 9. Five most common antimicrobial resistance patterns for top three *Salmonella* serotypes

Salmonella serotype	Number of isolates	Number of antibiotics for which there was resistance	Resistance pattern
Derby	3	0	
	49	11	Amox/Amp/Cefox/Cefti/Ceph/ Chlor/Kan/Strep/Sulfa/Tet/Trisul
	47	3	Strep/Sulfa/Tet
	30	1	Tet
	10	10	Amox/Amp/Cefox/Cefti/Ceph/ Chlor/Strep/Sulfa/Tet/Trisul
	8	2	Kan/Tet
Typhimurium (Copenhagen)	2	0	
	29	5	Amp/Chlor/Strep/Sulfa/Tet
	4	1	Tetra
	3	5	Amp/Kan/Strep/Sulfa/Tet
	2	6	Amp/Ceph/Kan/Strep/Sulfa/Tet
	2	4	Amp/Chlor/Sulfa/Tet
Typhimurium	12	0	
	10	5	Amp/Kan/Strep/Sulfa/Tet
	8	6	Amp/Ceph/Kan/Strep/Sulfa/Tet
	7	5	Amp/Chlor/Strep/Sulfa/Tet
	1	10	Amox/Amp/Cefox/Cefti/Ceph/Chlor/ Kan/Strep/Sulfa/Tet
	1	7	Amox/Amp/Ceph/Kan/Strep/Sulfa/Tet

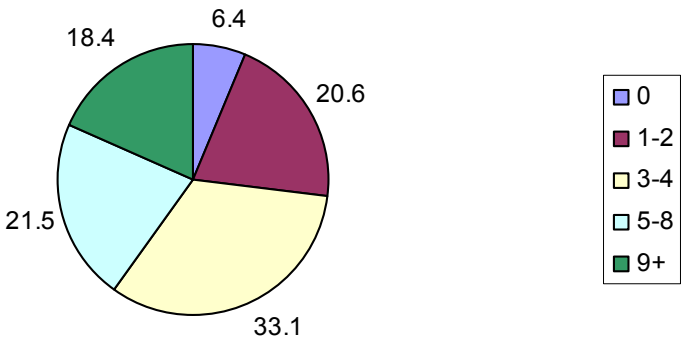
Except for the first quarter when resistance to one or two antimicrobials was most common, *Salmonella* isolates were most commonly resistant to three or four antimicrobials. Only 39.8 percent of isolates were resistant to more than four antimicrobials. Isolates that were resistant to more than eight antimicrobials were identified in all four quarters.

Figure 9. Percent of *Salmonella* isolates resistant to the specified number of antibiotics by quarter



When isolates from all quarters were combined, the most common number of antimicrobials that isolates were resistant to was 3 to 4, followed by 5 to 8. Only 6.4 percent of all isolates were pan-susceptible (fig. 10).

Figure 10. Percent of *Salmonella* isolates resistant to the specified number of antibiotics, Quarters 1-4



Sampling and Recovery of enteric organisms—Campylobacter

All sites and most pens (68.7 percent) where samples were collected between July 1, 2004, and June 30, 2005, were positive for *Campylobacter.* Approximately half (49.7 percent) of samples were positive for *Campylobacter*.

Table 10. Number of fecal samples collected and *Campylobacter* prevalence, by *State*

	Sites	Pens	Samples	
State	Number sampled	Number sampled	Number collected	Number tested
IA	10	123	825	330
MN	13	241	1360	528
MO	12	162	1240	480
NC	10	140	770	292
TX	3	24	160	64
Total	48	690	4355	1694

Table 11. Number of fecal samples collected and *Campylobacter* prevalence, by type of site

	Sites		Pens		Samples		
Sows present on site	Number sampled	Number positive for Campylobacter	Number sampled	Number (%) positive for Campylobacter	Number collected	Number tested	Number (%) positive for Campylobacter
No	28	28	442	321 (72.6%)	2,460	952	570 (59.9%)
Yes	20	20	248	153 (61.7%)	1,895	742	272 (36.7%)
Total	48	48	690	474 (68.7%)	4,355	1,694	842 (49.7%)

Table 12. Number of fecal samples collected and *Campylobacter* prevalence, by type of facility

	Sites		Pens		Samples		
Hogs with outdoor access	Number sampled	Number positive for Campylobacter	Number sampled	Number (%) positive for Campylobacter	Number collected	Number tested	Number (%) positive for Campylobacter
No	35	35	577	408 (70.7%)	3,180	1,240	676 (54.5%)
Yes	13	13	113	66 (54.4%)	1,175	454	166 (36.6%)
Total	48	48	690	474 (68.7%)	4,355	1,694	842 (49.7%)

Antimicrobial resistance—Campylobacter

Similar to *Salmonella,* the highest percentage of *Campylobacter* isolates were resistant to tetracycline. Table 13 shows the number of isolates resistant to each antibiotic tested during the first half of the reporting year (July 2004–December 2005). For the purpose of this analysis, isolates that were classified as intermediate were considered susceptible. Resistance among *Campylobacter* isolates is limited for the most part to tetracycline, azithromycin, erythromycin, and chloramphenicol. No resistance to clindamycin or gentamicin was identified.

Table 13. Number and percent of *Campylobacter* isolates resistant to each antibiotic tested from July 2005–December 2005

Antibiotic	Number isolates resistant	Percent of isolates resistant (n=832)
Tetracycline	290	34.8%
Erythromycin	236	28.4%
Azithromycin	235	28.2%
Chloramphenicol	200	24.0%
Nalidixic Acid	16	1.9%
Ciprofloxacin	11	1.3%
Gentamicin	0	0%
Clindamycin	0	0%

Beginning in January 2005, *Campylobacter* isolates were tested for susceptibility to antibiotics using a broth microdilution method. In addition, the panel of antibiotics tested was changed. Currently, only limited interpretive criteria are available for this method so here we report the minimum inhibitory concentrations (MIC) for the isolates. Table 13a shows the MIC for the antibiotics tested from January through June 2005.

Table 13a. Minimum Inhibitory Concentration (MIC) for *Campylobacter* prevalence from January—June 2005 (n=424)

Antibiotic	MIC_{50}	MIC_{90}	MIC_{95}
Azithromycin	128.00	128.00	128.00
Ciprofloxacin	0.06	0.12	4.00
Clindamycin	4.00	8.00	16.00
Erythromycin	128.00	128.00	128.00
Florfenicol	0.50	1.00	1.00
Gentamicin	0.50	1.00	1.00
NalidixicAcid	4.00	8.00	64.00
Telithromycin	8.00	16.00	16.00
Tetracycline	64.00	128.00	128.00

Antimicrobial resistance—E. coli

For the purpose of this analysis, isolates that were classified as intermediate were considered susceptible. As with the *Salmonella* isolates, almost all isolates (91.7 percent) are resistant to tetracycline (table 14). The majority of isolates were not resistant to the remaining antimicrobials. In general, the descending order of resistance of *Salmonella* isolates is similar to the descending order of resistance among *E. coli* isolates. However, the percentage of *Salmonella* isolates resistant to a particular antibiotic is higher than *E. coli* isolates in every case except for tetracycline and gentamicin.

Table 14. Number and percent of *E. coli* isolates resistant to each antibiotic tested

Antibiotic	Number isolates resistant	Percent isolates resistant (n=1488)
Tetracycline	1364	91.7%
Sulfamethoxazole	617	41.5%
Streptomycin	425	28.6%
Kanamycin	373	25.1%
Ampicillin	356	23.9%
Chloramphenicol	188	12.6%
Cephalothin	149	10.0%
Trimethoprim/sulfa	68	4.6%
Gentamicin	32	2.2%
Amoxicillin/clavulanic acid	26	1.7%
Ceftiofur	22	1.5%
Cefoxitin	21	1.4%
Nalidixic acid	0	0%
Ciprofloxacin	0	0%
Ceftriaxone	0	0%
Amikacin	0	0%